TITLE OF THE INVENTION

[0100] Stacked Assembly of Roofing Caps

INVENTOR

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CROSS-REFERENCE TO RELATED APPLICATIONS

[0300] This application is a continuation-in-part of pending U.S. Non-Provisional Application 10/435,737 (filed May 9, 2003), also entitled "Stacked Assembly of Roofing Caps" and fully included herein by reference, and claims priority benefit thereof and of the parent applications of said Application 10/435,737. Application 10/435,737, in turn, was a division of pending U.S. Non-Provisional Application 09/648,335 (filed August 25, 2000), entitled "Staple or Nail Gun Assembly, Cap Gun Feeding Device for Staple or Nail Gun, and Cap Assembly" and fully included herein by reference, and claims priority benefit thereof and of the parent applications of said Application 09/648,335. Application 09/648,335, in turn, was a continuation-in-part of U.S. Non-Provisional Application 09/438,983 (filed November 12, 1999), entitled "Staple or Nail Gun Assembly, Cap Feeding Device for Staple or Nail Gun, and Cap Assembly" and claimed priority benefit of said Application 09/438,983, which has now issued as U.S. Patent No. 6,302,310 (issued October 16, 2001). Application 09/648,335 also claimed priority benefit of U.S. Provisional Application 60/150,534 (filed August 25, 1999), entitled "Stacked Felt Caps for the Rapid Feeding Felt Cap Gun," and also claimed priority benefit of U.S. Provisional Application 60/160,672 (filed October 21, 1999), entitled "Stacked Feltcaps Held Together with Plastic Line or Wire or Tube." Application 09/438,983, in turn, claimed priority of U.S. Provisional Application

60/108,174 (filed November 13, 1998), entitled "Rapid Feeding Felt Cap Gun & Felt Caps Glued Together."

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0400] Not applicable.

REFERENCE TO COMPACT DISC(S)

[0500] Not applicable.

FIELD OF THE INVENTION

[0600] This invention relates to a cap feeding device for a staple or nail gun, as well as a staple or nail gun assembly and a cap assembly for use with a cap feeding device.

BACKGROUND OF THE INVENTION

[0700] Automatic nail guns, powered by compressed air or electricity, are used, for example, to attach roofing material, such as tarpaper, to the roof of a house. A generally flat cap is often used with each nail. A nail penetrates the cap and the tarpaper and protrudes into the underlying roof structure, attaching the roofing material to the roof surface.

[0800] Typically, an operator must manually place and hold a cap under the nose of a nail gun and then trigger the gun to drive a nail through the cap into the roof structure. The manual placement of caps presents a serious safety hazard to the operator because the operator's hand is close to the nose of the gun when a nail is driven through the nose of the gun. In addition, manual placement of caps is time-consuming and inefficient.

[0900] A cap feeding device may be employed to reduce the risk associated with manual placement of caps and to improve the efficiency of roofing operation. The cap feeding device automatically places a cap under the nose of a nail gun, and then the nail gun drives a nail through the cap and into the underlying roof structure.

[1000] A conventional cap feeding device generally includes a cap container and a base

having a channel. The base extends between the cap container and a position under the nose of the nail gun. Caps are fed into the channel of the base from the cap container and pushed to the position under the nose of the nail gun. When the gun is triggered, a nail penetrates and dislodges the cap under the nose of the nail gun and protrudes into the underlying roof structure. The feeding of the caps under the nose of the nail gun is coordinated with the ejection of the nails through the nose of the nail gun, so that a cap is placed under the nose of the gun before the gun is triggered to expel a nail.

[1100] Conventional cap feeding devices have a number of drawbacks. For example, conventional cap feeding devices are generally heavy, putting additional stress on the operator's hand holding the nail gun. Also, many conventional cap feeding devices can only be installed close to the front end of a nail gun, making the nail gun not only heavy but also unbalanced with most of the weight placed at the front end of the gun. This makes the nail gun difficult to handle and may put stress on the operator's hand and wrist. In addition, with so many components placed near the nose of the gun, it is difficult to see the position of the nose of the gun, making a precise placement of a nail difficult.

[1200] The conventional cap feeding devices are installed close to the front end of the gun because designers need to place a conventional cap container close to the nose of the gun to reduce the weight of the cap feeding device. The reason is that in many devices a cap is pushed directly from the cap container to a position under the nose of the nail gun. Thus, if the cap container is far from the nose of the gun, a long shuttle is needed to push a cap from the container to the position under the nose of the nail gun through the channel of the base. In addition, an actuator, such as an air cylinder, with a long displacement is also needed to drive the shuttle. The displacement of the actuator should be about the same as the distance between the cap container and the nose of the nail gun. A long shuttle and actuator increase the weight and size of the cap feeding device. With the cap feeding device placed near the nose of the gun, the shuttle and actuator, thus the cap feeding device can be made lighter, smaller and less expensive.

[1300] Caps for automatic nailing guns are available in a wide variety of shapes and packaging. Most caps for felt roofing products are sold in bulk and must be applied singularly with each nailing operation. Automatic nailers for roofing including magazines containing caps are available, however, for a variety of reasons, have not found wide usage. Most of the disadvantages of nailers including magazines of roofing caps are related to the unwieldiness of the apparatus, and somewhat to the lack of reliability or uniformity of operation. Automatic nailing machines adapted for installing roofing caps are illustrated in such as patents 5,947,362 to Omli; 5,445,297; 5,184,752; and 5,042,142. None of these prior automatic roofing nailers provide the versatility and ease of usage, incorporate the use of an inventive roofing cap or disclose a convenient packaging of stacked caps which may be readily inserted into the magazine of an automatic roofing nailer. Not only does the cap of the present invention lend itself to convenient packaging, but it also provides superior reliability in its ability to be routinely fed through the magazine chamber of the nailing machine for reliable operation, but the configuration which provides the fit, reliability and stackability also provides a cap which delivers superior performance in holding the material to be attached such as roofing felt to the roof or siding materials.

SUMMARY OF THE INVENTION

[1400] This invention provides a compact, light-weight cap feeding device that overcomes the problems associated with conventional nail guns and cap feeding devices.

[1500] In accordance with one aspect of the invention, a device, which is used to feed, staple or nail caps having a diameter, includes a base, a container and a shuttle. The base includes cap feeding and cap holding chambers, and a channel connecting the two chambers. The distance between the cap feeding and cap holding chambers is at least twice the diameter of the caps. The container has a generally cylindrical configuration and is substantially perpendicular to the base. The container is operatively associated with the cap feeding chamber and is adapted to feed caps stored in the container into the cap feeding chamber one

cap at a time. The shuttle is adapted to slide within the channel of the base and is adapted to move a cap at the cap feeding chamber through the channel towards the cap holding chamber by a distance equal to a diameter of the cap.

[1600] In accordance with another aspect of the invention, a staple or nail gun assembly includes a staple or nail gun and a cap feeding device. The staple or nail gun has a head portion and a handle portion. The head portion has an opening through which a staple or nail is expelled. The handle portion has first and second ends, the first end being attached to the head portion. The cap feeding device includes a base, a container and a shuttle. The base includes cap feeding and cap holding chambers, and a channel connecting the two chambers. The distance between the cap feeding and cap holding chambers is at least twice the diameter of the caps. The container has a generally cylindrical configuration and is substantially perpendicular to the base, facilitating the transfer of caps from the container to the cap feeding chamber. The container is operatively associated with the cap feeding chamber and is adapted to feed caps stored in the container into the cap feeding chamber one cap at a time. The shuttle is adapted to slide within the channel of the base and is adapted to move a cap at the cap feeding chamber through the channel towards the cap holding chamber by a distance equal to a diameter of the cap.

[1700] In accordance with a further aspect of the invention, a cap assembly for use with a cap feeding device includes a plurality of concentrically stacked staple or nail caps. Each cap has two opposite surfaces, and at least one of the surfaces of each cap is attached to one of the surfaces of another cap.

[1800] The cap feeding device and the staple or nail gun assembly of the present invention are compact and light-weight and thus have a number of advantages over the prior art. The weight of a staple or nail gun assembly in accordance to the present invention is substantially balanced. The weight of the staple or nail gun is mostly located at the front end of the gun handle, while the weight of the cap feeding device, especially the weight of the cap container, is mostly located at the rear end of the gun handle. Further, although the cap

container is not placed near the nose of the gun, an actuator with a long displacement is not needed because a cap is not pushed directly from the cap feeding chamber to the cap holding chamber. The cap in the cap feeding chamber is pushed by the shuttle towards the cap holding chamber by a distance equal to the diameter of the cap (if the cap is circular). This cap pushes the cap in front of it in the channel towards the cap holding chamber by the same distance. The last cap is pushed into the cap holding chamber, where a staple or nail penetrates the cap in the cap holding chamber when the gun is triggered. In other words, there are at least three caps in the channel of the base, one at the cap feeding chamber, one at the middle position and one at the cap holding chamber. Each time after the gun is triggered, the caps are moved towards the cap holding chamber by a distance equal to the diameter of the caps. In addition, because most of the components of the cap feeding device are not located near the nose of the gun, an operator is able to see the nose of the gun better, allowing him to more precisely aim the nose of the gun.

[1900] Additional objects of the present invention are roofing caps having a disk-like circular shape including a peripheral ridge on the lower surface of the cap and a central portion being in the shape of a truncated cone exhibiting a flat plateau in the central portion of the truncated cone. Alternative embodiments of the cap include a lateral peripheral rim on the upper surface of the cap providing a complimentary surface for receiving the peripheral ridge of the adjacent stacked cap.

[2000] In accordance with still further objectives of the present invention are stacking means by which a plurality of caps may be stacked in vertical relation and retained for inventory and shipment and later inserted into the magazine of a nailing machine with a minimum of effort. Alternative embodiments of such stacking means include the caps having a hole centrally disposed in the plateau whereby a plastic cord or wire may be strung through the adjacent holes of stacked caps in which the lower portion of the cord or wire is terminated by a releasable fixture and the upper end may be terminated with such as a loop. Alternative means of stacking caps within the invention include caps having disposed thereon

a retaining stud on the upper or lower surface of the cap and the opposite surface having a complementary receiving hole disposed therein. Additional alternative means of stacking caps include a skewer rod through the caps or melting the caps together in a stacked assembly. The inventive caps may similarly be retained in stacks by means of an adhesive, such as a hot melt adhesive, disposed between adjacent surfaces of stacked caps.

BRIEF DESCRIPTION OF THE DRAWINGS

[2100] Figure 1 is a perspective view of a staple or nail gun assembly according to the present invention.

[2200] Figure 2 is a side view of a cap container of the embodiment shown in Figure 1, where the cover is in the open position.

[2300] Figure 3 is the side view of the cap container shown in Figure 2, where the cover is in the closed position.

[2400] Figure 4 is a rear view of the cap container shown in Figures 2 and 3.

[2500] Figure 5 is a top view of a base, a shuttle and a piston-cylinder arrangement of the embodiment shown in Figure 1.

[2600] Figure 6 is an exploded view of a mechanism for holding a cap in the cap holding chamber of the base.

[2700] Figure 7 is a top view of the shuttle shown in Figure 5.

[2800] Figure 8 is a schematic drawing of the system controlling the movement of the shuttle.

[2900] Figure 9a is a top view of a cap of the present invention.

[3000] Figure 9b is a cross sectional drawing of the cap shown in Figure 9a.

[3100] Figure 9c is a top view of an alternative embodiment of the cap of the present invention.

[3200] Figure 9d is a cross sectional drawing of the cap shown in Figure 9c.

[3300] Figure 9e is a top view of an alternative embodiment of the cap of the present

invention.

[3400] Figure 9f is a cross sectional drawing of the cap shown in Figure 9e.

[3500] Figure 9g is a top view of an alternative embodiment of the cap of the present invention.

[3600] Figure 9h is a cross sectional drawing of the cap shown in Figure 9g.

[3700] Figure 10 is an elevational view, partially in section of the cap shown in Figure 9f.

[3800] Figure 11 is an elevational view, partially in section of the cap shown in Figure 9d installed on a roof deck.

[3900] Figure 12 is a partial sectional elevational view of a stack of caps being fed according to the present invention.

[4000] Figure 13 is an elevational view of a stack of caps according to the present invention.

[4100] Figure 14 is an elevational view of an alternative embodiment of a stack of caps according to the present invention.

[4200] Figure 15 is an elevational view of an alternative embodiment of a stack of caps according to the present invention.

[4300] Figure 16 is a bottom view of the stack of caps shown in Figure 15.

[4305] Figures 17-19 show a fourth alternative embodiment of assembling a stack of caps according to the present invention.

[4310] Figure 17 is a side and partial sectional view of the fourth alternative embodiment.

[4315] Figure 18 is an enlarged view of the tip of the retaining rod of the fourth alternative embodiment.

[4320] Figure 19 is an enlarged view of the fourth alternative embodiment showing the piercing of the bottom cap by the tip of the retaining rod.

[4325] Figures 20-24 show a fifth alternative embodiment of assembling a stack of caps according to the present invention.

[4330] Figure 20 is a front side view of a stack of caps assembled according to the fifth alternative embodiment. The view from the back side is substantially identical.

[4335] Figure 21 is a top view of the stack of caps of Figure 20, taken substantially along the line 21-21 shown in Figure 20.

[4340] Figure 22 is an end view of the sled used in making the stack of caps assembled according to the fifth alternative embodiment, showing the lid of the sled being opened in dotted outline.

[4345] Figure 23 is a top view of the sled used in making the stack of caps assembled according to the fifth alternative embodiment, showing the lid of the sled opened.

[4350] Figure 24 is a front view of the sled of the fifth alternative embodiment shown passing between the laser melting means.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[4400] Figures 1-8 illustrate one example of the staple or nail gun assembly **10** of the present invention. The staple or nail gun assembly **10** includes a staple or nail gun **20** and a cap feeding device **40**. The staple or nail gun **20** has a handle portion **22** and a head portion **30**. The handle portion **22** has front and rear ends **24, 26**, the front end **24** being attached to the head portion **30**. The cap feeding device **40** includes a base **50**, a cap container **60** and a shuttle **80**. The base **50** includes a cap feeding chamber **52** and a cap holding chamber **54**, and a channel **56** connecting the two chambers **52, 54**. The container **60** is used to store staple or nail caps **140** and to feed the caps **140** to the cap feeding chamber **52** of the base **50** one cap at a time. The shuttle **80** is movably disposed in the channel **56** of the base **50** and is adapted to move a cap at the cap feeding chamber **52** towards the cap holding chamber **54** through the channel **56**.

[4500] In the preferred embodiment shown in Figure 1, the staple or nail gun **20** is an automatic nail gun powered by compressed air, although any staple or nail gun can be used with an embodiment of present invention, including a staple or nail gun powered, for

example, by electricity. The head portion **30** of the nail gun **20** includes a nose portion **32** and a barrel having an opening **34** at the nose portion **32**. The nail gun **20** may also include a nail container **36** connected to the head portion **30**. The nail container **36** holds a plurality of nails and feeds the nails into the barrel one nail at a time. The head portion **30** may also include a piston-cylinder arrangement, in which a piston is movably disposed in a cylinder and divides the cylinder into first and second chambers. When the nail gun **20** is triggered, compressed air is supplied to the first chamber of the cylinder to push the piston towards the nail in the barrel. The piston strikes the nail in the barrel to eject the nail through the opening **34** at the nose portion **32**. Then compressed air can be supplied to the second chamber to return the piston to the retracted position. Alternatively, the piston may be returned to the retracted position with any alternative device such as a spring. Because the head portion **30**, which contains most of the nail gun components, is disposed at the front end **24** of the handle portion **22**, the weight of the staple or nail gun **20** is mostly placed at the front end **24** of the handle **22**.

[4600] As stated above, the cap feeding device **40** includes a base **50**, a cap container **60** and a shuttle **80**. The base **50** has a cap feeding chamber **52** and a cap holding chamber **54**, and a channel **56** connecting the two chambers **52, 54**. The container **60** is used to store nail caps **140** and to feed the caps **140** to the cap feeding chamber **52** of the base **50** one cap at a time. The shuttle **80** is operatively associated with the channel **56** of the base **50** and pushes a cap at the cap feeding chamber **52** towards the cap holding chamber **54** through the channel **56**.

[4700] As illustrated in Figures 2-4, the cap container **60** includes a hollow tubular portion **62** having first and second open ends **64, 66**, and a cover **68** pivotably connected to the tubular portion **62** at the first open end **64**. The second open end **66** of the tubular portion **62** is aligned with the cap feeding chamber **52** of the base **50**, and the caps **140** in the container **60** are fed to the cap feeding chamber **52** through the second open end **66**. In this embodiment, the tubular portion **62** is attached to the base **50** with a plurality of bolts and

nuts. In the illustrated preferred embodiment, the tubular portion **62** is perpendicular to the base **50**. The container **60** also includes a plunger **70**, which may be disposed in the tubular portion **62** or disposed in the cover **68**, and a spring **72**, such as a ribbon spring **72** shown in Figures 2-4, pulling the plunger **70** towards the second end **66** of the tubular portion **62**. The spring force biases the plunger **70** against the stack of caps **140** in the direction of the second end **66** to ensure that the outermost cap at the second end **66** is disposed in the cap feeding chamber **52** of the base **50**. In the embodiment shown in Figures 2-4, the tubular portion **62** includes a longitudinal slot **76** in its wall, and the plunger **70** disposed in the tubular portion **62** includes a knob **78** extending to the exterior of the tubular portion **62** through the longitudinal slot **76**. The cover **68** may also include a slot **82** aligned with the slot **76** of the tubular portion **62** so that the plunger **70** can be lifted into the cover **68** from the tubular portion **62** by pulling the knob **78** or a handle **84** attached to the knob **78**. When the plunger **70** is in the cover **68**, the cover **68** can be placed in the open position, as shown in Figure 2, and the spring force keeps the cover **68** in the open position. After the cover **68** is placed in the open position, a coaxial stack of caps **140** can be disposed in the tubular portion **62**. Then the plunger **70** is put back in the tubular portion **62** and the cover **68** is placed in the closed position, as shown in Figure 3.

[4800] In a preferred embodiment shown in Figures 9a and 9b, the caps **140** each have two opposite surfaces **142, 144** with at least one surface **142, 144** of each cap attached to a surface **142, 144** of another cap. In a preferred embodiment, the cap is circular, with a diameter of about 1 inch and a thickness of about 1/16 inch. The caps **140** can be attached to one another in several ways. For example, the caps **140** may be glued to each other, or they may be attached by friction fit. Alternatively, the stack of caps may include grooves on the opposite sides of the stack, and the caps may be held together with a string, such as a wax or plastic string, disposed on the grooves. A stack of caps **140** may include any number of caps, for example, 100 caps. A stack of caps **140** attached to each other is easier to handle and to load into the cap container **60**.

[4900] The base **50** has a generally flat, elongated rectangular configuration and is used to transport caps **140** from the cap feeding chamber **52** to the cap holding chamber **54** under the nose **32** of the nail gun **20**. The cap feeding and cap holding chambers **52, 54** are disposed respectively near the first and second ends **86, 88** of the base **50**. The distance between the cap feeding and cap holding chambers **52, 54** is such that the cap feeding chamber **52** (and thus the cap container **60**) is near the rear end **26** of the handle portion **22**, and the cap holding chamber **54** is under the nose **32** of the nail gun **20**. The cap feeding chamber **52** includes an indentation having a configuration similar to that of the caps **140** for accommodating a cap. In the illustrated embodiment, for example, the cap feeding chamber **52** includes an indentation having a circular configuration which is similar to the flat circular configuration of the caps **140**. The cap holding chamber **54** has a generally circular through hole having a configuration similar to that of caps **140**.

[5000] A cap holding mechanism may be provided to hold a cap in the cap holding chamber **54** and to allow a cap to go through the cap holding chamber **54** when a nail is ejected through the nose **32** of the nail gun **20** and strikes the cap. The cap holding mechanism **53** used in the illustrated embodiment is shown in Figure 6. The cap holding mechanism **53** includes a feeding pawl **58** and a spring **57**. The feeding pawl **58** and spring **57** are attached to the base **50** by a bracket **55**. The spring **57** presses the feeding pawl **58** against a ledge **59** which extends from the bottom of the channel **56** into the circular cap holding chamber **54**. As a cap is pushed into the cap holding chamber **54**, the cap passes between the ledge **59** and the feeding pawl **58**. When the cap is placed in the cap holding chamber **54**, the feeding pawl **58** presses the cap against the ledge **59** and holds the cap in the cap holding chamber **54**. When a nail is ejected through the nose **32** of the nail gun **20** and strikes the cap, the feeding pawl **58** releases the cap and allows the cap to go through the cap holding chamber **54**.

[5100] The channel **56** extends between the cap feeding chamber **52** and the cap holding chamber **54**. At the cap feeding chamber **52**, the channel **56** extends beyond the cap feeding

chamber **52** and intersects the first end surface **86** of the base **50** to form an opening **90**. Preferably, the bottom surface of the cap feeding chamber **52** is flush with the bottom surface of the channel **56** so that a cap disposed in the cap feeding chamber **52** can be pushed into the channel **56** towards the cap holding chamber **54**. At the cap holding chamber **54,** the channel **56** does not extend beyond the cap holding chamber **54** so that a cap can only be fed to the cap holding chamber **54** from the channel **56** but not beyond cap holding chamber **54**. The channel **56** has a cross section similar to the cross section of the caps **140**. For example, the channel **56** in the illustrated embodiment has a rectangular cross section with its width similar to the diameter of the caps **140** and with its height similar to the height of the caps **140**. In this way, only one cap can be pushed into the channel **56** from the cap feeding chamber **52**, and the channel **56** can accommodate only one cap at any particular position.

[5200] As illustrated in Figures 4, 5, 7 and 8, the shuttle **80** has a generally flat rectangular configuration. At least a portion of the shuttle **80** is movably disposed in the channel **56** of the base **50** through the opening **90** of the channel **56**. The rest of the shuttle **80** may be outside of the channel **56** or may also be disposed in the channel **56**. Preferably, the cross section of the shuttle **80** is similar to or slightly smaller than that of the caps **140** and that of the channel **56**. Preferably, the cross section of the shuttle **80** is similar to or slightly smaller than that of the caps **140** and that of the channel **56**. In the illustrated embodiment, the first end **92** of the shuttle **80** is outside of the channel **56** while the second end of the shuttle **80** is disposed in the channel **56**. The shuttle **80** is movable within the channel **56** between a forward position and a back position. At the forward position, the second end **94** of the shuttle **80** is between the cap feeding chamber **52** and the cap holding chamber **54**. At the back position, the second end **94** is between the cap feeding chamber **52** and the opening **90** of the channel **56**. When the shuttle **80** moves from the back position to the forward position, the second end **94** of the shuttle **80** pushes a cap in the cap feeding chamber **52** towards the cap holding chamber **54** by a distance substantially equal to the diameter of each of the caps **140**. Preferably, the second end **94** of the shuttle **80** has a

semicircular configuration that conforms to the side surface of each of the caps **140**.

[5300] As shown in Figures 1, 5 and 8, a piston-cylinder arrangement **100**, powered by compressed air, is connected to that portion of the shuttle **80** outside of the channel **56** (or any portion of the shuttle **80**) to move the shuttle **80** in the channel **56**. Alternatively, any linear or rotational actuator, such as an electric or hydraulic motor, may be used to move the shuttle **80** in a desired manner. Although not shown in the Figures, a shield or guard may be provided to cover the moving piston and/or the first end **92** of the shuttle **80** to protect the operator from injury. The cylinder **102** includes a forward chamber **104** and a back chamber **106**, which are separated by the piston **108**. Compressed air can be supplied either to the forward chamber **104** or to the back chamber **106** to move the piston **108** within the cylinder **102**. The supply of compressed air to the chambers **104**, **106** of the cylinder **102** is controlled by a four-way, two-position valve **110**, as shown in Figure 8. Compressed air can be supplied to the cylinder **102** from the nail gun **20** or from another source.

[5400] The positioning of the valve **110**, thus the movement of the piston **108** and the shuttle **80**, is coordinated with the relative movement of the nail gun **20** and the cap feeding device **40**. The nail gun **20** and the cap feeding device **40** are pivotably attached to each other at a joint **150**. A spring **120** disposed between and connected to the nail gun **20** and the cap feeding device **40** normally biases the cap feeding device **40** and the nail gun **20** against each other and keeps the nose portion **32** of the nail gun **20** apart from the cap holding chamber **54** of the base **50**. When the base **50** is placed on a roof surface and the nail gun **20** is pressed towards the base **50**, the spring **120** is compressed, allowing the nose portion **32** to be positioned just above the cap holding chamber **54**. In this position, the nail gun **20** can be triggered to expel a nail through the opening **34** of the nose **32**.

[5500] The coordination between the movement of the shuttle **80** and the relative movement between the nail gun **20** and the cap feeding device **40** can be explained while referring to the schematic drawing in Figure 8. The four-way, two-position valve **110** includes an air pressure port **112**, an exhaust port **114**, and forward and back ports **116**, **118**

connected respectively to the forward and back chambers **104**, **106** of the cylinder **102**. At the first valve position **130**, the pressure port **112** is connected to the back port **118**, and the exhaust port **114** is connected to the forward port **116**. Compressed air is supplied to the back chamber **106** of the cylinder **102**, and the forward chamber **104** is connected to the exhaust port **114**. At the second valve position **132**, compressed air is supplied to the forward chamber **104**, and the back chamber **106** is connected to the exhaust port **114**. Normally, the nail gun **20** and the cap feeding device **40** are kept apart by the spring **120**, and the valve **110** is in the first position. At this position, compressed air is supplied to the back chamber **106**, and the shuttle **80** is in the back position. When the nail gun **20** is pressed towards the base **50** of the cap feeding device **40**, the spring **120** is compressed, and the spring **120** pushes the valve **110** into the second position **132**. At this position, compressed air is supplied to the forward chamber **104** and the shuttle **80** is moved to the forward position.

[5600] The operation of the nail gun assembly **10**, which includes the cap feeding device **40**, can be described while referring to Figures 1-8. If the cap container **60** is empty at the beginning of the operation, the plunger **70** can be lifted into the cover **68**, and the cover **68** can be placed in the open position. A stack of caps **140** attached to one another is disposed in the cap container **60**. The plunger **70** then is put back into the container **60**, and the cover **68** is placed in the closed position. If there are no caps in the channel **56** of the base **50** at this time, caps **140** can be fed into the channel **56**. To do so, the nail gun assembly **10** is placed on a surface such as a roof surface, and the nail gun **20** is pressed towards the base **50** to compress the spring **120**. The spring **120** then presses the valve **110** to put the valve **110** in the second valve position, and compressed air is supplied to the forward chamber **104** of the cylinder **102** and pushes the piston **108** to the forward position. The shuttle **80** is pushed to the forward position by the piston **108**, and the shuttle **80** pushes the cap in the cap feeding chamber **52** towards the cap holding chamber **54** by a distance equal to the diameter of one of the caps **140**. When the nail gun assembly **10** is lifted off the roof surface, the spring **120**

pushes the nail gun **20** and the cap feeding device **40** apart, and the valve **110** returns to the first valve position. The shuttle **80** is moved back to the back position and a cap is fed into the cap feeding chamber **52**. This is repeated until the channel **56** is full of caps but a cap is not yet fed into the cap holding chamber **54**. While doing this, the nail gun **20** need not be triggered to discharge a nail each time a cap is advanced in the channel **56**. After a cap is loaded into the cap holding chamber **54**, the nail gun assembly **10** is ready for use. The nail gun assembly **10** can then be placed on a piece of roof material, such as a piece of tarpaper, placed over a roof surface. The nail gun **20** is pressed towards the base **50**. The shuttle **80** moves to the forward position and pushes the cap in the cap feeding chamber **52** towards the cap holding chamber **54** by a distance equal to the diameter of the cap **140**. Also, the cap next to the cap holding chamber **54** is pushed into the cap holding chamber **54**. Then, the nail gun **20** is triggered to eject a nail through the opening **34** on the nose **32**. The nail penetrates the cap in the cap holding chamber **54** and the tarpaper, and protrudes into the roof structure. The tarpaper is attached to the roof surface by the nail with a cap disposed between the tarpaper and the head of the nail. When the nail gun assembly **10** is lifted off the roof surface, the shuttle **80** moves back to the back position, and a cap is fed into the cap feeding chamber **52**. Then, the nail gun assembly **10** is again ready for use.

[5700] Referring now to Figures 9a through 9h, the preferred embodiments of caps **140** are illustrated. As illustrated in Figures 2 - 4, caps **140** are stored in cap container **60** to be singularly forwarded by cap feeding device **40** for installation. Caps according to the present invention have a configuration which facilitates the separation of an individual cap **140** from a stack and the feeding through the cap feeding mechanism **40** to ensure uniform supply of caps **140** and reliable operation of staple gun **20**. Upper surface **142** of cap **140** includes a margin **146** disposed around the periphery of cap **140**. Inwardly of margin **146** is a conical section **148** which slopes upwardly from the rim toward a top plateau **151** of the cap **140** at angle α of preferably about 20 degrees from the horizontal plane of cap **140**, although angles of from about 10 degrees to about 30 degrees are operable. The periphery of cap **140** is

defined by a side wall **154** and a bottom wall **156**. Internally of bottom wall **156** is interior vertical wall **158** which terminates at a conical section **160** forming generally the undersurface of cap **140**, conical section **160** proceeds centrally to a bottom plateau **162** essentially parallel to top plateau **151** forming the remainder of the interior relatively concave surface of washer **140**. In the illustrated embodiment of Figures 9c and 9d, a hole **164** is centrally located between top plateau **151** and bottom plateau **162**. The function of hole **164** will be subsequently described. Walls **154, 156** and **158** define a peripheral rim **168** being a circular band, the function of which will be subsequently described.

[5800] Roofing washer **140** illustrated in varying preferred embodiments in Figures 9a through 9h is specially adapted to be loaded into a magazine **60** for a roof nailing machine as is illustrated in the present invention. The inventive washer embodies several features which facilitate its being prepackaged in a stack of a convenient number, such as 100 caps for loading in such as magazine **60** to be singly fed through cap feeding device **40** in a reliable sequential manner providing the user of staple or nail gun assembly **10** an uninterrupted supply of caps **140** so long as there remain caps in magazine **60**. Special features of cap **140** which enable the exemplary service of the present invention are the lower peripheral rim **168** which is formed by side wall **154**, bottom wall **156** and interior wall **158**. Peripheral rim **168** provides stability to a stack of caps **140** such as illustrated in Figure 3 and facilitates the individual feeding of the caps **140** by shuttle **80** as illustrated generally in Figures 3 - 6 and additionally subsequently described. As previously stated, caps **140** are preferably about one inch in diameter and exhibit a general thickness of approximately 1/16th inch and composed of a plastic material well known in the art for such purposes. However, the vertical extent of cap **140** with the domed and rimed construction stands approximately 1/8 inch above baseline **B** to top line **T**, because of the downwardly extending rim **168** and the conical dome formed by conical section **148** and top plateau **151**. Upper surface **142** of cap **140** is composed of margin **146** which extends horizontally from side wall **154** toward the center of cap **140**, a distance preferably at least twice the thickness of rim **168**, which in the illustrated

embodiment is approximately 1/16 inch in thickness. Margin **146** provides the resting surface for a cap stacked immediately above it as is illustrated in Figure 10. Accordingly, margin **146** extends roughly 1/8th inch radially inwardly of side wall **154** to form a junction **147** and meets conical surface **148**. As is illustrated in Figure 9d, conical surface **148** extends upwardly to top plateau **151** which describes a circular area of approximately 3/8 inch in diameter thereby forming a truncated cone. Correspondingly, the lower cap surface is preferably defined by conical section **160** which extends upwardly and inwardly from side wall **158** to a generally circular bottom plateau. In the illustrated embodiment, the diameter of bottom plateau **162** is approximately 7/16th inch. In the embodiment illustrated, it should be noted that the relative thickness of cap **140** adjacent junction **147** is less than elsewhere in cap **140**.

[5900] Figure 10 illustrates the relationship of adjacent caps when stacked illustrating that upon stacking, bottom rim **168"** of upper cap **140"** provides spacing from the lower cap **140'** such that the top plateau of bottom cap **140'** is disposed adjacent and touching the bottom plateau **162"** of upper cap **140** as the rim **168"** of cap **140"** rests firmly on the margin **146'** of lower cap **140'**. In such arrangement, the stack of caps **140** provide a stable vertical orientation so as to be conveniently packaged in a vertical stack of caps of a convenient number such as 100, the packaging of such a stack of caps being subsequently described.

[6000] Figure 11 illustrates the superior holding capacity of cap **140** when disposed on a roof surface **170** holding a layer of felt roofing paper **172** by means of nail **174**. It will be seen that the entry of nail into the roof surface **170** draws the top and bottom plateaus of cap **140** downwardly toward roof surface **170** such that bottom plateau **162** engages roof felt **172** holding it firmly against roof surface **170**. Concurrently as the general conical surfaces **148** and **160** are drawn downwardly by nail **174**, the peripheral rim **168** also engages roofing felt **172** firmly because of the resilient nature of cap material **140**. Accordingly, with cap **140** in position as illustrated in Figure 11, a secure holding of roofing felt **172** is accomplished on the roof surface **170**. Cap **140** and nail may also be utilized to secure other building materials

such as polyethylene or Styrofoam sheeting.

[6100] Referring now to Figure 12, the function of the cooperating surfaces of cap **140** as a cap is urged off of the bottom of the stack of caps **140** by shuttle **80** will now be explained. As shuttle **80** advances as indicated in the arrows, it feeds cap **140'** laterally such that the rim **168"** of the cap **140"** immediately above cap **140'** slides along margin **146'**. As may be seen in Figure 12, the stack of caps **140** being contained within the tubular member **62** of container **60**, rim **168'** of cap **140'** clears the extent of tubular member **62** in a lateral direction before the rim **168"** of cap **140"** reaches the innermost extent of margin **146'**. The relative dimensions of the various mentioned structural features of caps **140** enable the cap **140'** being fed to clear the tubular member **62** in respect of rim **168'** before rim **168"** slides up in the upper conical section **148'** during the feeding process. By allowing leading edge of cap **140'** to clear tubular member **62** prior to the stack of remaining caps **140** within tube **62** having to accommodate the upper conical section **148**, a smooth feeding transition and sliding of the remaining caps through the upper cap **140"** is accomplished. This combination of relative movement of rim **168** on margin **146** and the conical surfaces **148** avoids disjointed surfaces to enable the reliable consistent feeding of caps **140** by shuttle **80**.

[6200] Because of the various previously mentioned surface features of caps **140** enable a smooth, consistent, reliable feeding of a bottom cap in a stack through a feeding shuttle **80** as illustrated, caps may be conveniently stacked through several inventive means. Cap **140** illustrated in Figure 9c containing hole **164** may be stacked and bound in a convenient package by such as a line or wire traversing the stack of caps **140** as illustrated in Figures 13 and 14. In Figure 13 caps **140** are held together with a thermoplastic cord **180** such as is utilized in plastic rotary lawn trimmers, *i.e.*, of the type sold under the trademark "Weed Eater" owned by Aktiebolaget Electrolux. A plastic cord of a thickness of 0.050 to 0.065 inches in thickness are conveniently utilized. Such plastic cord is available in hardware suppliers in such sizes. A suitable length of plastic cord **180** is fed through the stack of caps **140** to a degree where it exits the bottom of the stack of caps **140**. A knob or knot of material

may be formed as at **182** at the lower reach of the stack of caps **140** to retain the caps on the plastic cord. Preferably the cord may be touched as with a hot iron to melt the thermoplastic cord **180** to form an enlarged portion or knob as at **182**, the enlarged portion having a diameter slightly larger than hole **164**. The stack of caps are thus securely retained on cord **180**. The cord may be conveniently terminated at the top of its extent by a convenient loop **184** as illustrated in Figure 13. The loop again may be formed as by tying or melting of the thermoplastic cord, as at region **186** as illustrated. When the caps are thus installed into container **60** of nailing machine **10**, the cap is directed into tube **62** and the top of the caps are pressed lightly off of the cord **180** into or towards the bottom of tube **62** which is then closed as described previously.

[6300] Figure 14 describes an alternative similar embodiment wherein the stack of caps **140** are held together with a metal wire in a manner similar to plastic cord in Figure 13. The wire is fed through the hole **164** of the stack tack of caps until it exists the bottom cap of stack of caps **140**. A retainer may conveniently be formed at the bottom end of wire **190**, may be terminated as at **192** by creasing the metal wire into such as a triangular shape as illustrated. Caps **140** are thus securely retained on wire **190** until such time as inserted into tubular member **62** in a manner as previously described. Wire **190** is conveniently terminated at the upper portion of the stack as by twisting or tying the wire forming a loop **194**.

[6400] A third alternative of assembling a stack of caps is illustrated in Figures 15 and 16 by means of a cylindrical plastic tube **200** having a diameter just slightly larger than the diameter of caps **140**. Tube **200** is terminated at its lower end with such as flanges **202** to catch and retain caps **140** when inserted and stacked into tube **200**. The upper end of tube **200** may be terminated with a handle **204** such as illustrated or alternatively by a circular flange or the like similar to that illustrated in the lower portion of Figures 15 and 16, or in continuous circular flange. For added security, an adhesive label may be added over the top portion of tube **200** to ensure retention of the caps therein. On insertion of tube **200** into tube

62, tube **200** is withdrawn while maintaining pressure with stack of caps **140** such that flanges **202** are deformed to release caps **140**.

[6500] Figures 9e and 9f and Figure 10 illustrate an alternative style of cap which may be stacked and retained in a stack without independent means as illustrated in Figures 13 through 16. Cap **140** in Figures 9e and 9f include a small stud **210** disposed on the top plateau **151** of cap **140**. Stud **210** is centrally located on the top plateau **151** and in the illustrated embodiment is approximately 0.04 inches in diameter and extends upwardly from top plateau **151** in an amount approximately 0.40 inches. Bottom plateau **162** is adapted with a cooperating hole **212** into which stud **210** will be received when caps **140** are assembled in stacked relationship. Hole **212** in the illustrated embodiment is of a diameter slightly smaller than stud **210** being approximately 0.035 inches in diameter and the hole extends slightly greater depth than the height of stud **210** which in the illustrated embodiment is approximately 0.045 inches. Those skilled in the art will appreciate that the thickness and height of the described studs and cooperating hole may be varied in dimension without departing from the scope and spirit of the invention. Likewise, rather than a single centrally located stud and hole, other patterns might be selected with similarly suitable results such as offset pairs of triangularly or other locations about the center of top plateau **151**.

[6600] Figures 9g and 9h illustrate further embodiment of caps **140** wherein the region between top plateau **151** and bottom plateau **162** is solid. Stacks of caps **140** may be formed in stacked relationship with such as the illustrated cap by means of a nominal amount of adhesive such as a drop of hot melt adhesive placed on the top or bottom plateau during a stacking operation whereby once the adhesive has cooled, the caps are retained in stacked relation. Other adhesives may likewise be employed with the limiting factor being that the sheer strength of the adhesive when applied to the caps shouldn't exceed the material strength of the caps such that the top plateau **151** and bottom plateau **162** are sheared or otherwise disfigured during the feeding operation. Deterioration of the top plateau **151** could result in irregular feeding of the caps.

[6610] Figures 17-19 show a fourth alternative embodiment of assembling a stack of caps according to the present invention. A rigid retaining rod **220** or skewer passes axially through the caps **140, 140a**, which are preferably like those shown in Figs. 9c and 9d, heretofore discussed in detail. Caps **140** have a first diameter axial hole **160** similarly-sized as the axial diameter of rod **220** so that rod **220** can be slid through the aligned axial holes **160** of the stacked caps **140**. The tip **222** of rod **220** has a reduced-diameter neck **224** that is frictionally received into the reduced-diameter axial hole **160'** of the bottom-most cap **140a** as the tip **222**, having a larger diameter than reduced-diameter neck **224**, is piercingly inserted through the reduced-diameter hole **160'** of the bottom-most cap **140a**. The resilience of bottom-most cap **140a** causes the bottom-most cap **140a** to be retained about the reduced-diameter neck **224** of rod **220** as the hole **160'** constricts about neck **224** after tip **222** has passed therethrough, thereby holding the stack of caps **140, 140a** on the rod **220** until they are to be used.

[6620] Rod **220** further has a grasping loop portion **226**. To use this fourth alternative embodiment, the stacked assembly of caps is lowered into the feeding tower or container of a cap gun. The user then grasps the portion **226** while holding the stacked assembly of caps within the cap gun as by using a finger or thumb, and the user then pulls the rod **220** from the stacked assembly of caps, thereby causing the tip **222** and reduced-diameter neck **224** to become disengaged from bottom cap **140a** as the entire rod is withdrawn from the stacked assembly of caps, which are left in the gun for subsequent dispensing and nailing by the gun.

[6630] The use of a rigid retaining rod **220** as shown in Figs. 17-19 has an advantage over the use of thermoplastic cord as disclosed for the embodiment of Fig. 13, namely, that it is much easier to feed a rigid rod down through the caps during manufacture of the stacked assembly of caps than it is to feed a thermoplastic cord through the stacked assembly, thereby permitting faster assembly of the stacked caps. Additionally, during loading of the cap gun, the rigid rod holds the stacked assembly of caps more perfectly axially aligned because of the rigidity of rod **220** as compared to the flexibility of thermoplastic cord, thereby facilitating

the gun loading process and reducing loading time. If desired, the reduced-diameter neck **224** may be formed by cutting a circumferential groove around the end of rod **220** adjacent the pointed tip **222.**

[6650] Figures 20-24 show a fifth alternative embodiment of assembling a stack of caps according to the present invention. In this embodiment, the stacked assembly of caps **140** are held together by adjacent caps **140** being melted together at one or more places. Preferably the caps are melted together as by heating means such as a flame, a laser, hot air, or a heating element such as a soldering iron, preferably by having one or more melted portions **230** that run longitudinally along the circumferences of the stacked caps **140**. The caps **140**, being made of plastic material, melt when heated along melted portions **230**, thereby causing adjacent caps **140** to be meltingly held together.

[6660] To create this stacked assembly of caps **140**, the caps are preferably stacked within a sled **232** having a hinged lid **234** that opens for loading as shown in Fig. 23 and as shown in dotted outline in Fig. 22, with a well-known hinge **236** allowing hinged movement of lid **234** with respect to sled **232**. Longitudinal openings **238, 240** in the sled **232** and/or lid **234** expose portions of the caps **140** to be melted to each other. A latch or hook **242** on the sled **232** engages with a well-known conveyor or chain **244** that transports the sled **232** carrying the caps **140** past upper and lower lasers **246, 248** during manufacture. Lasers **246, 248** respectively shine through openings **240, 238** and respectively create melted portions **230** on the stacked caps **140** within the sled **232**.

[6670] The stacked assembly of caps **140** is thus retained together by the melted portions **230** and can be easily loaded into the feeding tower or container of a cap gun. As the gun dispenses each bottom-most cap, as by a reciprocating shuttle or the like, the plastic material of the melted portion holding the bottommost cap to the adjacent cap above will become broken, and the bottommost cap will become separated from the stacked assembly of caps and will be dispensed.

[6680] An advantage of this embodiment is that the stacked assembly of caps can be

easily removed as a unit from the feeding tower or container of the cap gun if the gun becomes jammed, so as to permit unjamming of the gun with subsequent reloading of the remaining caps of the stacked assembly. Other prior art solutions and other embodiments do not have this advantage that the caps remain held together in a stacked assembly when removed from the cap gun. A further advantage of this embodiment is that no rod or thermoplastic cord or string is required to hold the stacked assembly of caps together.

[6700] Various modifications may be made with respect to caps **140** and the stack retaining mechanisms without departing from the scope and spirit of the invention which is defined by means of the appendant claims. It is therefore to be understood that within the scope of the appendant claims the present invention may be practiced otherwise than as specifically described herein.